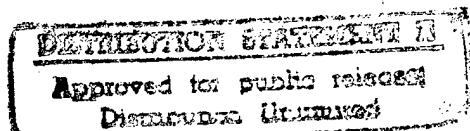


# ENERGY SAVING OPPORTUNITIES SURVEY ESOS

West Point  
Pre-Final Submittal  
AUGUST 1986  
Contract No. DACA 31-81-C-0112



For  
The Baltimore District  
Corps of Engineers

**VOLUME I of VI**  
**NARRATIVE REPORT**

BERNARD JOHNSON INCORPORATED  
ARCHITECTS ENGINEERS PLANNERS  
6500 ROCK SPRING DR. BETHESDA, MARYLAND 20817

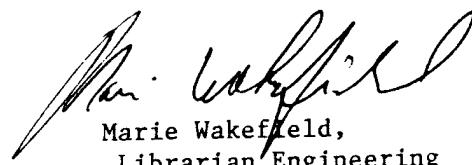


DEPARTMENT OF THE ARMY  
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS  
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CHAMPAIGN, ILLINOIS 61826-9005

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## EXECUTIVE SUMMARY

### I. INTRODUCTION

In the winter of 1980, the Army Corp of Engineers (COE), Baltimore District, advertised through the Commerce Business Daily for the services of an A/E firm with expertise in performing energy conservation surveys. The services of Bernard Johnson Incorporated (BJI) were retained in May, 1981, under contract number DACA-31-81-C-0112.

The purpose of this contract is to investigate a number of buildings, identified within the scope of work, for a set of energy conservation projects and determine their economic feasibility on a life-cycle basis.

Notice to proceed for West Point was issued by the Baltimore COE on September 2, 1983. Field surveys began in October of 1983 leading to preliminary submittal in January ,1984. The preliminary report provided the user with the results of the screening analysis of the projects within the scope of work based on the surveys. The Interim report submitted in August 1984 included energy saving and cost analyses representing approximately 70% of the entire effort.

This report represents the Pre-Final submittal of West Point Energy Savings Opportunities Survey (ESOS). It is an update of the Interim Report, which incorporates the review comments, as well as, completes over 95% of all saving and cost calculations for the energy conservation options for each building and provides programming documentation.

Developed projects have resulted in total annual energy savings of 176,600 MBTU which constitutes nearly 11.3% of the total energy consumption of West Point, at an estimated construction cost of \$3,838,000. Implementation of energy conservation options are expected to produce an annual dollar saving on the order of \$1,154,000.

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West Point Pre-Final Report has been organized into five volumes:

- o Volume I - has been subdivided into five sections.
  - Section 1 - Provides all the background information, methods of approach, and the economic parameters used to develop the projects.
  - Section 2 - Provides a brief description for every building within the scope of work, including the architecture of the building and the HVAC systems utilized. Additionally, building description section is used to account for all the projects within the scope of work and the results of the analyses. Section 2 also provides the summary of the results in a tabulated fashion.
  - Section 3 - Provides the energy consumption and cost figures for West Point.
  - Section 4 - Provides the report distribution list.
  - Section 5 - Provides the base site plan
- o Volumes II and III

Provides 1391 and 4283 programming documents for all projects which were determined to be economically feasible.
- o Volumes IV, V, and VI

Provide the method of calculations, all the back-up calculations including energy savings analyses, cost estimates, life-cycle cost analyses.

## II WEST POINT ENERGY CONSUMPTION

A summary of West Point facilities energy consumption for FY-81, FY-82, and FY-83 is shown in Table 1. This table indicates that energy consumption at the installation has dropped from FY 81 to FY 83 by 2.7%.

Figure 1 illustrates the total fixed facilities energy use at West Point by fuel type during FY 83. Electricity accounted for 37.9% of the total energy used, while natural gas accounted for 6.6%, oil #2 6.6% and oil #6 48.8% of the total energy consumption.

FIGURE 1

WEST POINT ENERGY CONSUMPTION BREAKDOWN FISCAL YEAR 1983 (MBTU)

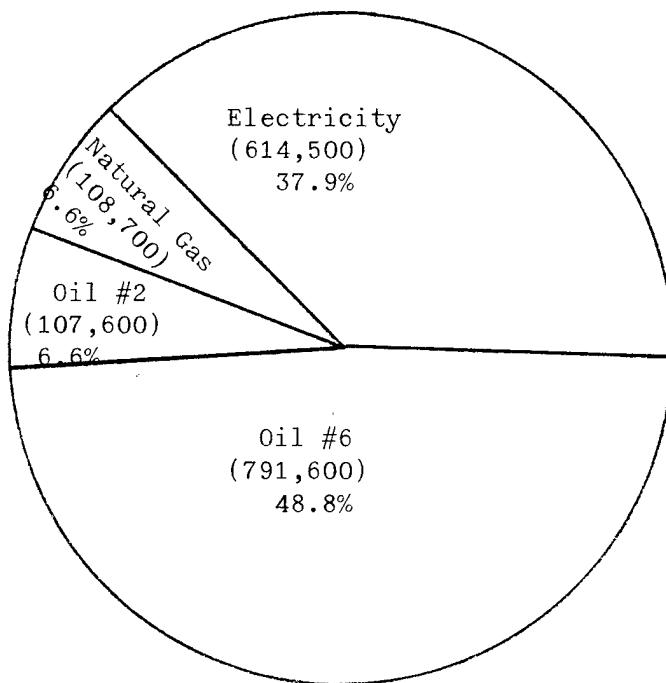


TABLE 1  
West Point's Energy Use  
Fiscal Year 81 through Fiscal Year 83

FUEL TYPE	FY 81 (MBTU)	FY 82 (MBTU)	FY 83 (MBTU)
Electricity	581,700	596,800	614,500
Natural Gas	127,800	128,500	108,700
Fuel Oil #2	108,200	120,200	107,200
Fuel Oil #6	<u>850,100</u>	<u>856,500</u>	<u>791,600</u>
TOTAL	1,667,800	1,702,000	1,622,000

### III. ENERGY CONSERVATION MEASURES DEVELOPED

Energy Savings Opportunities Survey (ESOS) conducted at West Point required investigation of a number of energy conservation measures. A total of 195 projects were found to be economically feasible based on life-cycle-cost analysis of about 460 projects. The feasible projects were then packaged, based on similarities, into 1391 and 4283 programming documents. A total of twelve 1391's and five 4283's were developed, which have been presented in Volumes II and III of this report.

Table 3 provides tabulated results of the feasible projects on a building basis, prioritized in the order of descending Savings-Investment-Ratio (SIR).

Table 4 provides tabulated results of the feasible projects from Table 3, which were packaged into 1391's and 4283's. The projects have been prioritized on the order of descending Savings-Investment-Ratio (SIR).

**TABLE 2**  
**PRIORITIZED LISTING OF  
 FEASIBLE PROJECTS  
 ON A BUILDING BASIS**

Bldg.	Energy Conservation Measure	COST		SAVINGS		Feasible? (Yes/No)
		Const Costs (\$)	Annual MBTU/YR	BTU/FT <sup>2</sup> YR	SIR	
149	Hot Water Temp Reduction	6	17.83	207	151.2	Yes
600	Hot Water Temp Reduction	11	4.8	57	18.1	Yes
601	Air Volume Reduction	15,860	2,967.8	8,205	13.2	Yes
	Enthalphy Economizer	30,364	1,069.2	2,956	2.9	Yes
	Outside Air Reduction	10,997	846.6	2,340	2.1	Yes
603	Air Volume Reduction	597	342	8,321	40.5	Yes
	Outside Air Reduction	11,267	3,743	90,998	28.5	Yes
	Induction Kitchen Hood	21,828	1,719	41,825	7.0	Yes
	Enthalpy Economizer	8,677	656	15,961	6.7	Yes
	Piping Insulation	628	23.05	560	3.2	Yes
	Multi-Set Back	12,011	364	8,856	2.7	Yes
	Lighting	25,355	515.6	12,544	1.1	Yes
	Inside Insulation	32,546	369.96	9,001	1.0	Yes
604	High Efficiency Fluorescent	5,520	175.9	4,343	1.8	Yes
605	H.W. Temp. Reduction	6	8.05	164	82.0	Yes
	Zone Control	4,410	132	2,677	2.6	Yes
	Multi-Set Back	15,141	271	5,497	1.6	Yes
606	Outside Air Reduction	3,995	753.47	6,535	16.4	Yes
618	Roof Insulation	14,523	172.96	12,267	1.0	Yes

TABLE 2

Bldg.	Energy Conservation Measure	COST		SAVINGS		Feasible? (Yes/No)
		Const Costs (\$)	Annual MBTU/YR	BTU/FT <sup>2</sup> YR	SIR	
620	Hot Water Temp Reduction	6	14.29	234	145.4	Yes
	Piping Insulation	341	56.33	1,055	15.6	Yes
	Ceiling Insulation	11,652	595.98	9,770	4.4	Yes
	Multi-Set Back	4,661	164	2,689	3.1	Yes
	Zone Control	9,045	124	2.033	1.2	Yes
	Inside Insulation	72,266	933.61	15,305	1.1	Yes
622 (Libr)	Outside Air Reduction	817	333.59	7,758	35.3	Yes
	Hot Water Temp Reduction	6	2.19	51	18.8	Yes
	Multi-Set Back	2,899	207.95	15,996	6.3	Yes
	Enthalpy Economizer	3,667	218	5,073	4.2	Yes
622 (Bowl)	Multi-Set Back	864	59.04	-	6.0	Yes
624	Hot Water Temp Reduction	6	21.43	371	218.2	Yes
	Piping Insulation	341	56.33	1,115	15.6	Yes
	Ceiling Insulation	2,665	195.36	3,386	6.5	Yes
	Multi-Set Back	4,661	164	2,689	3.1	Yes
	Roof Insulation	56,748	1108.08	19,204	1.7	Yes
	Zone Control	9,045	124	2,033	1.2	Yes
	Inside Insulation	72,266	861.71	14,934	1.1	Yes
626	Outside Air Reduction	191	138	3,538	62.8	Yes
	Air Volume Reduction	1,042	41	1,051	2.8	Yes
	Multi-Set Back	9,837	182	4,513	1.6	Yes
628	Ceiling Insulation	2,697	177.99	28,252	6.6	Yes
	MSB/ZC Combination	4,405	210	33,333	4.9	Yes
630	Zone Control	3,012	31.0	3,734	1.1	Yes

TABLE 2

Bldg.	Energy Conservation Measure	COST		SAVINGS		SIR	Feasible? (Yes/No)
		Const Costs (\$)	Annual MBTU/YR	BTU/FT <sup>2</sup> YR			
632	Zone Control/Multi-Set Back	6,742	270.2	6,464	3.5	Yes	
	Ceiling Insulation	12,402	151.30	3,620	1.1	Yes	
635	Ceiling Insulation	3,708	190.64	21,913	4.5	Yes	
639	Multi-Set Back	425	1,489.4	42,676	289.9	Yes	
	Piping Insulation	183	10.64	304	5.1	Yes	
	Hot Water Temp Reduction	584	22.63	648	3.4	Yes	
	Ceiling Insulation	4,986	127.61	3,656	2.2	Yes	
	Enthalpy Economizer	4,002	126.8	3,633	2.2	Yes	
	Outside Air Reduction	534	9.4	269	1.2	Yes	
	Zone Control	53,285	716.04	20,517	1.2	Yes	
	Bay Door W/S	1,099	29.43	843	1.2	Yes	
648	Multi-Set Back	1,585	277.00	27,700	15.4	Yes	
	Ceiling Insulation	17,426	662	66,200	3.3	Yes	
	Zone Control	2,010	64.00	6,038	2.8	Yes	
650	Multi-Set Back	144	90.00	20,455	64.6	Yes	
	Duct Insulation	99	7.27	1,652	6.5	Yes	
	Ceiling Insulation	1,620	99.06	22,514	6.3	Yes	
	Piping Insulation	94	1.67	380	1.7	Yes	
	Inside Insulation	8,171	80.67	18,334	1.0	Yes	
652	Piping Insulation	48	5.65	856	11.1	Yes	
	Ceiling Insulation	1,451	123.45	18,705	8.8	Yes	
	Inside Insulation	13,860	198.55	30,083	1.5	Yes	
	Personnel Door W/S	232	6.20	939	1.4	Yes	
654	Piping Insulation	74	11.55	1,343	14.7	Yes	
	Ceiling Insulation	1,451	123.45	14,355	8.8	Yes	
	Inside Insulation	13,860	198.55	23,087	1.5	Yes	
	Personnel Door W/S	232	6.20	721	1.4	Yes	

TABLE 2

Bldg.	Energy Conservation Measure	COST		SAVINGS		Feasible? (Yes/No)
		Const Costs (\$)	Annual MBTU/YR	BTU/FT <sup>2</sup> YR	SIR	
655	Hot Water Temp Reduction	6	5.43	28	49.0	Yes
	Multi-Set Back	10,609	2,712	14,125	22.5	Yes
	Ceiling Fans	3,909	303.22	1,579	6.9	Yes
	Enthalpy Economizer	5,724	451	2,349	5.6	Yes
	Outside Air Reduction	1,000	62.7	326	4.6	Yes
	CV to VAV	45,423	2,030.4	10,575	3.5	Yes
	Air Volume Reduction	95,395	2,752.34	14,335	2.1	Yes
	Induction Kitchen Hood	33,798	791.00	4,120	1.9	Yes
	Zone Control	90,603	1,581.2	8,235	1.2	Yes
	Bay Door W/S	1,151	28.23	147	1.1	Yes
	Heat Recovery	53,035	810.3	4,220	1.0	Yes
656	Piping Insulation	119	16.22	2,534	14.1	Yes
	Ceiling Insulation	1,451	123.45	19,289	8.8	Yes
	Inside Insulation	13,860	198.55	31,023	1.5	Yes
	Personnel Door W/S	232	5.48	856	1.3	Yes
658	Ceiling Insulation	639	40.25	15,481	6.3	Yes
	Duct Insulation	51	2.00	769	3.5	Yes
662	Multi-Set Back	940	83.00	12,206	9.1	Yes
	Ceiling Insulation	1,451	93.49	13,749	6.4	Yes
	Piping Insulation	228	6.17	907	2.5	Yes
	Inside Insulation	13,860	145.46	21,391	1.1	Yes
663	Hot Water Temp Reduction	6	16.56	180	149.4	Yes
	Ceiling Fans	22,646	1,124.67	12,237	4.5	Yes
664	Multi-Set Back	144	30	4,412	21.5	Yes
	Piping Insulation	130	23.22	3,415	16.7	Yes
	Ceiling Insulation	1,451	91.45	13,449	6.5	Yes
	Personnel Door W/S	174	3.44	506	1.1	Yes
	Inside Insulation	13,860	147.07	21,628	1.1	Yes
		Sum-9				

TABLE 2

Bldg.	Energy Conservation Measure	COST		SAVINGS		SIR	Feasible? (Yes/No)
		Const Costs (\$)	Annual MBTU/YR	BTU/FT <sup>2</sup> YR			
665	Ceiling Insulation	16,907	1187.63	35,033	6.2	Yes	
	Inside Insulation	7,040	143.33	4,228	1.8	Yes	
666	Multi-Set Back	144	51.00	19,615	38.7	Yes	
	Ceiling Insulation	639	37.47	14,412	5.8	Yes	
	Duct Insulation	85	4.94	1,900	5.1	Yes	
667	Hot Water Temp Reduction	12	24.44	130	84.8	Yes	
	Outside Air Reduction	267	18	96	4.8	Yes	
	Piping Insulation	158	6.6	35	3.7	Yes	
	Multi-Set Back	71,883	1,122	6,543	1.4	Yes	
668	Ceiling Insulation	1,619	102.13	24,910	6.5	Yes	
	Duct Insulation	72	3.06	746	3.7	Yes	
	Piping Insulation	219	3.36	820	1.4	Yes	
	Inside Insulation	8,144	84.30	20,561	1.1	Yes	
	Air Volume Reduction	3,443	23.00	5,610	1.0	Yes	
670	Hot Water Temp Reduction	6	2.08	184	21.2	Yes	
	Piping Insulation	340	64.80	5,735	19.7	Yes	
	Zone Control	4,291	82	13,903	2.0	Yes	
671	Multi-Set Back	863	116.48	43,141	11.9	Yes	
	Ceiling Insulation	682	39.98	14,807	5.2	Yes	
671A	Multi-Set Back	863	132.60	49,111	13.5	Yes	
	Ceiling Insulation	682	37.81	14,004	4.9	Yes	
681	Outside Air Reduction	267	81.00	2,040	26.4	Yes	
	Multi-Set Back	1,436	297.00	7,481	18.2	Yes	
	Zone Control	7,216	133.00	3,350	1.6	Yes	

TABLE 2

Bldg.	Energy Conservation Measure	COST		SAVINGS		Feasible? (Yes/No)
		Const Costs (\$)	Annual MBTU/YR	BTU/FT <sup>2</sup> YR	SIR	
684	Piping Insulation	34	3.49	1,058	9.6	Yes
	Multi-Set Back	863	52.56	15,927	5.7	Yes
	Ceiling Insulation	638	35.16	10,655	5.1	Yes
	Duct Insulation	38	0.91	276	2.0	Yes
	Inside Insulation	8,171	86.62	26,248	1.0	Yes
685	Hot Water Temp Reduction	6	5.21	82	53.0	Yes
	Air Volume Reduction	727	190.00	2,547	18.5	Yes
	Piping Insulation	356	58.48	925	15.4	Yes
	Ceiling Insulation	6,357	744.34	11,778	10.1	Yes
	Enthalpy Economizer	1,797	254.00	4,019	10.0	Yes
	Induction Kitchen Hood	6,185	216.41	3,424	3.1	Yes
	High Efficiency Fluorescent	43,989	964.2	15,257	1.2	Yes
	Multi-Set Back	35,404	452.00	7,152	1.1	Yes
687	Pipe Insulation	369	24.93	394	5.95	Yes
	Ceiling Insulation	40,785	631.21	9,987	1.4	Yes
	Inside Insulation	62,854	722.54	11,432	1.0	Yes
689	Multi-Set Back	431	208.25	22,392	42.5	Yes
692	Multi-Set Back	863	109.01	31,146	13.1	Yes
	Boiler Replacement	4,071	40.61	11,603	1.0	Yes
693	Ceiling Insulation	2,642	155.60	19,949	6.1	Yes
	Multi-Set Back	1,806	96.62	12,387	5.5	Yes
	Boiler Replacement	4,071	91.31	11,706	1.6	Yes
	Inside Insulation	18,265	240.29	30,806	1.4	Yes

TABLE 2

Bldg.	Energy Conservation Measure	COST		SAVINGS		SIR	Feasible? (Yes/No)
		Const Costs (\$)	Annual MBTU/YR	BTU/FT <sup>2</sup> YR			
705	Multi-Set Back	3,417	2,749.38	64,539	83.2	83.2	Yes
	Piping Insulation	27	3.73	88	13.0	13.0	Yes
705A	Multi-Set Back	3,417	1,418.49	43,503	42.9	42.9	Yes
706	Personnel Door W/S	123	7.36	898	3.3	3.3	Yes
719	Outside Insulation	17,238	211.65	50,393	1.1	1.1	Yes
720	Piping Insulation	432	90.56	2,736	18.4	18.4	Yes
	Multi-Set Back/Zone Control	57,612	715.88	21,628	1.1	1.1	Yes
721	Ceiling Insulation	75	10.64	1,935	14.5	14.5	Yes
	Piping Insulation	81	9.86	1,793	12.6	12.6	Yes
	Inside Insulation	4,690	180.36	32,793	4.0	4.0	Yes
	Bay Door W/S	1,454	57.69	10,489	2.1	2.1	Yes
727	Hot Water Temp Reduction	18	25.62	66	64.2	64.2	Yes
	Air Volume Reduction and Outside Air Reduction	44,775	24,051.75	62,037	49.5	49.5	Yes
733	Multi-Set Back	861	82.87	18,015	9.9	9.9	Yes
745 (A&B)	Air Volume Reduction & Outside Air Reduction	11,011	3,747.82	3,859	29.8	29.8	Yes
	Heat Recovery	20,332	782.92	806	3.4	3.4	Yes
	Induction Kitchen Hood	289,971	6,489.43	6,682	2.0	2.0	Yes
751	Hot Water Temp Reduction	6	28.89	232	260.6	260.6	Yes

TABLE 2

Bldg.	Energy Conservation Measure	COST		SAVINGS		Feasible? (Yes/No)
		Const Costs (\$)	Annual MBTU/YR	BTU/FT <sup>2</sup> YR	SIR	
752	Outside Air Reduction	15,385	3,596.56	18,673	20.4	Yes
	Air Volume Reduction	2,457	390.26	2,026	11.6	Yes
	Enthalpy Economizer	6,036	156.40	812	2.1	Yes
	Ceiling Insulation	21,916	369.66	1,919	1.5	Yes
	Inside Insulation	211,188	3,419.58	17,755	1.4	Yes
753	Multi-Set Back	15,877	9,416.7	45,823	52.2	Yes
	Air Volume Reduction and					
	Outside Air Reduction	10,573	1,580.45	7,690	12.6	Yes
	Ceiling Insulation	5,052	385.30	1,875	6.5	Yes
756	Hot Water Temp Reduction	6	6.25	20	56.4	Yes
	Floor Insulation	6,171	120.28	394	1.7	Yes
	Zone Control*	85,520	1,195	3,915	1.2	Yes
	Multi-Set Back	275,415	3,841	12,585	1.2	Yes
* "Zone Control" duplicated in "Multi-Set Back" project.						
757	Hot Water Temp Reduction	6	3.61	34	32.6	Yes
	Air Volume Reduction and					
	Outside Air Reduction	14,032	4,335.55	41,290	25.7	Yes
759	Multi-Set Back	10,726	1,892.11	18,020	14.3	Yes
	Hot Water Temp Reduction	6	3.89	360	33.0	Yes
	Ceiling Insulation	3,546	83.73	7,753	2.0	Yes
783	High Efficiency Fluorescent	812	18.7	1,731	1.3	Yes
	Ceiling Insulation	3,889	593.05	74,131	13.4	Yes
	Multi-Set Back	431	36.72	4,590	7.5	Yes
785	Ceiling Insulation	5,145	363.43	18,734	7.3	Yes
	Multi-Set Back	9,216	241.3	12,438	2.7	Yes

TABLE 2

Bldg.	Energy Conservation Measure	COST		SAVINGS		SIR	Feasible? (Yes/No)
		Const Costs (\$)	Annual MBTU/YR	BTU/FT <sup>2</sup> YR			
793	Heat Recovery	111,051	1,342	55,226		1.1	Yes
795	Heat Recovery	111,051	1,343	55,262		1.1	Yes
900	Multi-Set Back	1,412	3,792.4	26,896		213.2	Yes
	Air Volume Reduction and Outside Air Reduction	18,638	14,370.27	101,916		60.4	Yes
	Optimize Off Coil Temp	56,339	7,435.3	52,732		11.6	Yes
	Enthalpy Economizer	24,145	1,548.4	10,981		5.5	Yes
	Induction Kitchen Hood	59,272	1,912.65	13,564		2.9	Yes
	Bay Door W/S	767	34.99	248		2.1	Yes
	Heat Recovery	11,080	229.30	1,626		1.9	Yes
	CV to VAV	900,000	21,305.38	151,101		1.8	Yes
	High Efficiency Fluorescent	147,016	3,821	27,099		1.4	Yes
901	Multi-Set Back	431	20.19	2,804		4.8	Yes

**SUMMARY OF RESULTS OF  
FEASIBLE PROJECTS PACKAGED AS 1391 OR 4283**

Priority No.	Energy Conservation Opportunity Title	No. of Bldgs. Affected	Construction Cost (X \$1,000)	Annual Savings		Overall SIR	Document Type
				Energy (MBTU)	Cost (\$1,000)		
1	Outside Air & Air Volume Reduction	17	263	65,804	425	20.8	1391
2	Hot Water Temperature Reduction	17	0.7	213	1	14.3	4283
3	Optimize Off-Coil Temperature	1	56	7,435	47	11.6	1391
4	Pipe Insulation	19	4	480	3	10.7	4283
5	Ceiling Fans	2	27	1,428	9	4.8	1391
6	Duct Insulation	5	0.3	18	0.1	4.6	4283
7	Enthalpy Economizer	8	84	4,480	29	4.3	1391
8	Zone Control/ Multiple Set Back	38	751	36,405	247	4.3	1391
9	Ceiling/Roof Insulation	30	190	7,745	53	3.7	1391
10	Induction Kitchen Hood	5	411	11,128	70	2.4	1391
11	Constant Volume to Variable Air Volume Conversion	2	945	23,336	156	1.9	1391
12	Boiler Replacement	2	8	132	1	1.7	4283
13	Floor Insulation	1	6	120	0.8	1.7	1391
14	Bay Door & Personnel Door Weatherstripping	9	5	179	1	1.6	4283

TABLE 3

Priority No.	Energy Conservation Opportunity Title	No. of Bldgs. Affected	Construction Cost (X \$1,000)	Energy (MBTU)	Annual Savings Cost (X \$1,000)	Overall SIR	Document Type
15	Lighting Modifications	4	197	4,962	34	1.4	1391
16	Inside/Outside Wall Insulation	17	592	8,223	56	1.4	1391
17	Heat Recovery	5	298	4,508	28	1.3	1391
	TOTAL		3,838	176,596	1,161		